

WHAT IS CLAIMED IS:

- 1 1. An apparatus, comprising:
- 2 a cross correlator operable to receive a first audio signal
- 3 and a second audio signal, the cross correlator also operable to
- 4 cross correlate the first and second audio signals to produce a
- 5 cross-correlated signal;
- 6 at least one parameter identifier operable to receive the
- 7 cross-correlated signal and identify a plurality of parameters
- 8 associated with at least one of the first and second audio signals;
- 9 and
- 10 a score generator operable to receive the plurality of
- 11 parameters and generate an indicator identifying an extent to which
- 12 the first and second audio signals match.
- 1 2. The apparatus of Claim 1, wherein the at least one
- 2 parameter identifier comprises:
- 3 a delay identifier operable to identify a delay between the
- 4 first and second audio signals;
- 5 a correlation identifier operable to identify an amount of
- 6 correlation between the first and second audio signals; and
- 7 a pitch variation identifier operable to identify a variation
- 8 in pitch between the first and second audio signals.

1 3. The apparatus of Claim 2, wherein:
2 the delay identifier is operable to identify the delay by
3 identifying a maximum value in the cross-correlated signal;
4 the correlation identifier is operable to identify the amount
5 of correlation by normalizing the cross-correlated signal; and
6 the pitch variation identifier is operable to identify the
7 variation in pitch by identifying a coincidental harmonic frequency
8 using the cross-correlated signal.

1 4. The apparatus of Claim 2, wherein the score generator is
2 operable to generate the indicator by:
3 generating a first score using the delay between the first and
4 second audio signals and the amount of correlation between the
5 first and second audio signals;
6 generating a second score using the variation in pitch between
7 the first and second audio signals; and
8 combining the first and second scores to produce a final
9 score.

1 5. The apparatus of Claim 1, wherein the first audio signal
2 is associated with an input signal and the second audio signal is
3 associated with a reference signal; and

4 further comprising:

5 a plurality of decimators operable to receive and
6 decimate the input signal and the reference signal; and

7 a plurality of filters operable to filter at least one of
8 the input signal, the reference signal, a decimated input signal,
9 and a decimated reference signal.

1 6. The apparatus of Claim 5, wherein the plurality of
2 filters comprise:

3 a first anti-aliasing low pass filter operable to filter the
4 input signal, a first of the decimators operable to decimate the
5 filtered input signal;

6 a second anti-aliasing low pass filter operable to filter the
7 reference signal, a second of the decimators operable to decimate
8 the filtered reference signal;

9 a first band pass filter operable to filter the decimated
10 input signal to produce the first audio signal; and

11 a second band pass filter operable to filter the decimated
12 reference signal to produce the second audio signal.

1 7. The apparatus of Claim 1, further comprising a voice
2 activity detector operable to detect a voice in the input signal;
3 wherein the score generator is operable to generate the
4 indicator after the voice activity detector detects the voice in
5 the input signal.

1 8. The apparatus of Claim 1, wherein:
2 each of the first and second audio signals comprises a
3 plurality of frames; and
4 the cross correlator is operable to correlate one frame from
5 the first audio signal and multiple frames from the second audio
6 signal to produce the cross-correlated signal.

1 9. The apparatus of Claim 8, wherein the indicator
2 identifies an extent to which the one frame from the first audio
3 signal matches at least a portion of the multiple frames from the
4 second audio signal.

1 10. A method, comprising:
2 receiving a first audio signal and a second audio signal;
3 cross-correlating the first and second audio signals to
4 produce a cross-correlated signal;
5 identifying a plurality of parameters associated with at least
6 one of the first and second audio signals using the cross-
7 correlated signal; and
8 generating an indicator identifying an extent to which the
9 first and second audio signals match using the plurality of
10 parameters.

1 11. The method of Claim 10, wherein the plurality of
2 parameters comprise:
3 a delay between the first and second audio signals;
4 an amount of correlation between the first and second audio
5 signals; and
6 a variation in pitch between the first and second audio
7 signals..

1 12. The method of Claim 11, wherein identifying the plurality
2 of parameters comprises:

3 identifying the delay by identifying a maximum value in the
4 cross-correlated signal;

5 identifying the amount of correlation by normalizing the
6 cross-correlated signal; and

7 identifying the variation in pitch by identifying a
8 coincidental harmonic frequency using the cross-correlated signal.

1 13. The method of Claim 11, wherein generating the indicator
2 comprises:

3 generating a first score using the delay between the first and
4 second audio signals and the amount of correlation between the
5 first and second audio signals;

6 generating a second score using the variation in pitch between
7 the first and second audio signals; and

8 combining the first and second scores to produce a final
9 score.

1 14. The method of Claim 10, wherein the first audio signal is
2 associated with an input signal and the second audio signal is
3 associated with a reference signal; and

4 further comprising:

5 decimating the input signal and the reference signal; and

6 filtering at least one of the input signal, the reference
7 signal, a decimated input signal, and a decimated reference signal.

1 15. The method of Claim 14, wherein filtering at least one of
2 the signals comprises:

3 anti-alias low pass filtering the input signal;

4 anti-alias low pass filtering the reference signal;

5 band pass filtering the decimated input signal to produce the
6 first audio signal; and

7 band pass filtering the decimated reference signal to produce
8 the second audio signal.

1 16. The method of Claim 10, further comprising detecting a
2 voice in the input signal;

3 wherein generating the indicator comprises generating the
4 indicator after detecting the voice in the input signal.

1 17. The method of Claim 10, wherein:
2 each of the first and second audio signals comprises a
3 plurality of frames; and
4 cross-correlating the first and second audio signals comprises
5 cross-correlating one frame from the first audio signal and
6 multiple frames from the second audio signal to produce the cross-
7 correlated signal.

1 18. A computer program operable to be executed by a
2 processor, the computer program comprising computer readable
3 program code for:

4 receiving a first audio signal and a second audio signal;

5 cross-correlating the first and second audio signals to
6 produce a cross-correlated signal;

7 identifying a plurality of parameters associated with at least
8 one of the first and second audio signals using the cross-
9 correlated signal; and

10 generating an indicator identifying an extent to which the
11 first and second audio signals match using the plurality of
12 parameters,

1 19. The computer program of Claim 18, wherein the plurality
2 of parameters comprise:

3 a delay between the first and second audio signals;

4 an amount of correlation between the first and second audio
5 signals; and

6 a variation in pitch between the first and second audio
7 signals.

1 20. The computer program of Claim 19, wherein the computer
2 readable program code for identifying the plurality of parameters
3 comprises computer readable program code for:

4 identifying the delay by identifying a maximum value in the
5 cross-correlated signal;

6 identifying the amount of correlation by normalizing the
7 cross-correlated signal; and

8 identifying the variation in pitch by identifying a
9 coincidental harmonic frequency using the cross-correlated signal.

1 21. The computer program of Claim 19, wherein the computer
2 readable program code for generating the indicator comprises
3 computer readable program code for:

4 generating a first score using the delay between the first and
5 second audio signals and the amount of correlation between the
6 first and second audio signals;

7 generating a second score using the variation in pitch between
8 the first and second audio signals; and

9 combining the first and second scores to produce a final
10 score.

1 22. The computer program of Claim 18, wherein the first audio
2 signal is associated with an input signal and the second audio
3 signal is associated with a reference signal; and

4 further comprising computer readable program code for:

5 decimating the input signal and the reference signal; and

6 filtering at least one of the input signal, the reference
7 signal, a decimated input signal, and a decimated reference signal.

1 23. The computer program of Claim 22, wherein the computer
2 readable program code for filtering at least one of the signals
3 comprises:

4 computer readable program code for anti-alias low pass
5 filtering the input signal;

6 computer readable program code for anti-alias low pass
7 filtering the reference signal;

8 computer readable program code for band pass filtering the
9 decimated input signal to produce the first audio signal; and

10 computer readable program code for band pass filtering the
11 decimated reference signal to produce the second audio signal.

1 24. The computer program of Claim 18, further comprising
2 computer readable program code for detecting a voice in the input
3 signal;

4 wherein the computer readable program code for generating the
5 indicator comprises computer readable program code for generating
6 the indicator after detecting the voice in the input signal.

1 25. The computer program of Claim 18, wherein:

2 each of the first and second audio signals comprises a
3 plurality of frames; and

4 the computer readable program code for cross-correlating the
5 first and second audio signals comprises computer readable program
6 code for cross-correlating one frame from the first audio signal
7 and multiple frames from the second audio signal to produce the
8 cross-correlated signal.